

## THE PHYTOPHAGOUS INSECT FAUNA OF THE INTRODUCED SHRUBS *SIDA ACUTA* BURM.F. AND *SIDA CORDIFOLIA* L. IN THE NORTHERN TERRITORY, AUSTRALIA

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### Abstract

The phytophagous insect fauna on the malvaceous weeds *Sida acuta* Burm.f. and *S. cordifolia* L. are recorded for the Northern Territory, Australia. Most of the 20 insect species on *S. acuta* and the 23 insect species on *S. cordifolia* are rarely or only occasionally encountered, are native or naturalized, polyphagous, ectophagous chewing or sucking species. *S. cordifolia* is more fully exploited by phytophagous insects than is *S. acuta* but vacant niches exist on both plants for introduced insects for biological control of these weeds.

### Introduction

*Sida acuta* Burm.f. and *S. cordifolia* L. (Malvaceae) are both perennial weeds of improved pastures, disturbed areas and roadsides in northern Australia (Kleinschmidt and Johnson 1977; Mott 1980). They are small, erect shrubs with woody stems and deep taproots, usually growing to about 1 m in height but exceeding 2 m in favourable circumstances. These species can dominate areas which are heavily grazed.

*S. acuta* is native to Mexico and central America and is thought to have been introduced into Australia approximately 100 years ago (Waterhouse and Norris 1987). It can tolerate dry or wet climates, droughts and a range of soil types but is rarely found outside the tropics (Holm *et al.* 1977). The origin of *S. cordifolia* is less certain. It is pan-tropical in distribution and has been in Australia for at least 140 years (Bentham 1863). Both species are widespread in the monsoonal regions of the Northern Territory from the Victoria River district in the west to the Gulf of Carpentaria in the east.

In 1984 a biological control programme for these weeds was commenced with the establishment of an exploratory station in Mexico funded by both the CSIRO Division of Entomology and the Northern Territory Department of Primary Industry and Fisheries. The aim was to search the Americas for damaging natural enemies of *Sida* spp. and to introduce into Australia those that passed stringent host-specificity tests. The study reported here attempted to reveal any vacant niches on *Sida* spp. in the Northern Territory which might be exploited by imported natural enemies.

### Materials and Methods

Between 1984 and 1987, immature and mature phytophagous insects were hand-picked or aspirated from seedlings and mature plants of *S.*

*acuta* and *S. cordifolia* on 50 collecting trips to infestations of both these species in the Northern Territory. At least 1 h was spent collecting on each species on each trip and collections were made during daylight hours and in every month of the year. Flowers, fruit, leaves, roots and stems were all examined carefully for signs of insect herbivory. Damage was correlated whenever possible to the species and stages of insects present. In a shadehouse, the immature insects collected were reared to adults on their *Sida* host plant. Bulk collections of excised mature fruits were made whenever possible and were held in cages in an insectary for the emergence of seed-feeding insects.

Only insects which fed on living tissues of *S. acuta* and *S. cordifolia* were included in the phytophagous insect fauna. Transient insects were not included.

## Results

### *Sida acuta*.

A total of 20 species of phytophagous insects, representing five orders, 15 families and 19 genera, were found feeding on *S. acuta* (Table 1). Nine species were considered rare (i.e. encountered on no more than three occasions), seven were encountered occasionally (i.e. on up to 10 occasions) and four were considered common, being found on more than 10 occasions.

Fourteen of the 20 species that fed on *S. acuta* were known to breed on it and two were endophagous. Fifteen species fed on leaves, two on flowers, one on fruits, three on seeds and three on stems. No insects were observed to feed on the roots. At least 11 species were polyphagous, feeding on plants from more than one family. The host ranges of the remaining nine species could not be determined. Nine species were known pests of cultivated plants.

### *Sida cordifolia*.

A total of 23 species of phytophagous insects, representing four orders, 16 families and 22 genera, were found feeding on *S. cordifolia* in the Northern Territory (Table 1). Eight species were considered rare, eight were encountered occasionally and seven were common (criteria as above).

Fifteen of the 23 species that fed on *S. cordifolia* were known to breed on it and two were endophagous. Fifteen species fed on leaves, five on stems, two on fruits, three on flowers and three on seeds. No insects were observed to feed on the roots. At least nine species were polyphagous, three were considered to be oligophagous, feeding only on plants within the Order Malvales and the host ranges of the

remaining 11 species could not be determined. Seven species were known pests of cultivated plants.

Although there are native representatives of the genus *Sida* in the Northern Territory (Dunlop 1987), no native or naturalized insect species known to be restricted to the genus *Sida* were found on the introduced *Sida* spp. Eight species utilized both *S. acuta* and *S. cordifolia*.

### Discussion

*S. acuta* and *S. cordifolia* have attracted at least 20 and 23 species of phytophagous insects respectively since their introduction into the Northern Territory a century or more ago (Table 1). Many are extremely uncommon on their new host plants and even those that were encountered frequently were not always present in damaging numbers.

Only the seed-sucking *Oxycarenus luctuosus* Montrouzier and Signoret, was found in large numbers on *S. acuta*. It was not surprising that in the field *S. acuta* rarely displayed evidence of herbivory. On the other hand, *S. cordifolia* supported six species of insects that damaged the plant extensively. They were: *O. luctuosus* on mature fruits, *Urentius sarinae* Hacker on the leaf surfaces, *Melanagromyza* sp. mining under the epidermis of the stems, *Syllepte quaternalis* Zeller rolling and chewing leaves, *Earias smaragdina* Butler chewing fruits and leaves, and *Crocidosema plebejana* Zeller chewing flowers, fruits and leaves. In the field *S. cordifolia* invariably showed evidence of insect herbivory, with many leaves rolled and chewed, fruits and flowers damaged and stems mined.

It is unlikely that a suite of phytophagous insects came with *S. acuta* and *S. cordifolia* when they arrived in Australia, since none of the 39 insect species reported as feeding on *S. acuta* in its native range in Mexico (Gillett, Harley and Miranda unpubl. results) was common to either *S. acuta* or *S. cordifolia* here. Colonists are usually drawn rapidly and asymptotically from the pool of native and naturalized insects which have the potential to include the new plant in their diet (Lawton and Strong 1981; Strong *et al.* 1977).

It is usually the least specialized, chewing and sucking, externally feeding insects that rapidly transfer to a colonizing plant species (Strong *et al.* 1984). We would therefore expect to see a relatively low proportion of endophagous insects attacking *S. acuta* and *S. cordifolia* in their recently acquired introduced range and a relatively higher proportion in the native range of *S. acuta*. As most plant species used in agriculture in Australia have also been introduced, we would expect that a number of the unspecialized native or naturalized insects that have become pests on these plants would also include the exotic *Sida*

TABLE 1. Phytophagous insects associated with *Sida acuta* and *S. cordifolia* in the Northern Territory.

Taxonomy	Relative frequency in collections (a)	Stages collected (b)	Associated plant parts (c)	Host relationship of plant to insect (d)	Host specificity (e)
Coleoptera					
Apionidae					
<i>Apion</i> sp.	O	A	Fl	ECT	?
Buprestidae					
<i>Cissis</i> sp.	X	A	Fl	ECT	?
Chrysomelidae					
<i>Nisotra</i> sp.	X	A	L	ECT	?
Diptera					
Agromyzidae					
<i>Melanagromyza</i> sp.	O	L,P,A	St	END	?
Hemiptera (Heteroptera)					
Lygaeidae					
<i>Nysius vinitor</i> Bergröth	C	N,A	Se	ECT	P,E (2,3,6-8)
<i>Oxycarenus luctuosus</i> Montrouzier & Signoret	C	N,A	Se	ECT	P,E (1,2,5)
Miridae					
gen. et sp. indeterminate	X	A	L,St	ECT	?
Pyrrhocoridae					
<i>Dysdercus sidae</i> Montrouzier	X	A	Se	ECT	P,E (1-3,6,7)
Rhopalidae					
<i>Liorrhysus hyalinus</i> (Fabricius)	O	A	Se	ECT	P,E (6)
Tingidae					
<i>Urentius sarinae</i> Hacker	X	N,A	L	ECT	O

Table 1 (Continued)

Hemiptera (Homoptera)							
	Aphidae						
O	<i>Aphis gossypii</i> Glover	O	N,A	L,St	ECT	P,E (1-5,7,8)	
Cicadellidae							
X	<i>Austroasca viridigrisea</i> (Paoli)	O	N,A	L	ECT	P,E (1-3,5,7,8)	
O	<i>Balclutha incisa</i> Matsumura	O	N,A	L	ECT	?P	
X	<i>Balclutha rubrostrigata</i> Melichar	X	A	L	ECT	P	
X	<i>Orosius lotophagorum</i> (Kirkaldy)	O	A	L	ECT	?	
R	<i>Zygnina</i> sp. nov. '6'	X	A	L	ECT	?P	
R	genus 'DLXX' (Deltocephalinae)	X	A	L	ECT	?	
Dictyopharidae							
X	<i>Dictyophara australiaca</i> (Lallemand)	R	A	St	ECT	P	
Machaerotiidae							
X	<i>Machaerota pugionata</i> Stål	O	N,A	St	ECT	P	
Pseudococcidae							
O	<i>Macroneillicoccus hirsutus</i> (Green)	X	N,A	L,St	ECT	P,E (4,5)	
Tropiduchidae							
R	? <i>Montrouzierana</i> sp.	X	A	L	ECT	P	
Lepidoptera							
R	gen. et sp. indeterminate No. 1	X	L	L	ECT	?	
R	gen. et sp. indeterminate No. 2	X	L	L	ECT	?	
Geometridae							
R	<i>Cleora repetta</i> Butler	X	L	L	ECT	P	
Gracillariidae							
R	gen. et sp. indeterminate	X	L	L	ECT	?	
R	gen. et sp. indeterminate	X	L,P	L	END	?	

(possibly nr *Bedellia*)



**TABLE 1 (Cont.).** Phytophagous insects associated with *Sida acuta* and *S. cordifolia* in the Northern Territory.

Taxonomy	Relative frequency in collections (a)		Stages collected (b)	Associated plant parts (c)	Host relationship of plant to insect (d)		Host specificity (e)
	On <i>S. acuta</i>	On <i>S. cordifolia</i>			Fed on	Bred on	
Noctuidae							
<i>Acontia</i> sp.	X	R	L	L		ECT	?
<i>Erias smaragdina</i> Butler	X	C	L	Fr,L		ECT	O
<i>Heliothis armigera</i> (Hübner)	C	X	L	L		ECT	P,E (1-8)
<i>Heliothis punctigera</i> Wallengren	C	X	L	L		ECT	P,E (1-3,5-8)
Pyralidae							
<i>Notarcha derogata</i> (Fabricius)	X	R	L	L		ECT	O,E (4)
<i>Syllepte quaternalis</i> Zeller	X	C	L	L		ECT	?
gen. et sp. indeterminate (Phycitinae)	X	R	L	L		ECT	?
Tortricidae							
<i>Crociosema plebejana</i> Zeller	R	C	L	Fl,Fr,L		ECT	P,E (1,2,7)
Orthoptera							
Tettigoniidae							
<i>Caedicia</i> sp.	O	X	A	L		ECT	P,E (8)

(a) R, rare; O, occasional; C, common; X, not found.

(c) Fl, flowers; Fr, fruit; L, leaves; Se, seeds; St, stems.

(e) As determined from the literature, examination of insect collections and expert advice. O, oligophagous, known only from order Malvales; P, polyphagous, known from other plant families; ?, host range not known; E, economic pest species, minor vs. major pest status not distinguished (1, Forrester and Wilson 1988; 2, Hassan 1977; 3, Hely *et al.* 1982; 4, Kalshoven 1981; 5, Richards 1968; 6, Shepard *et al.* 1983; 7, Swaine and Ironside 1983; 8, Swaine *et al.* 1985).

(b) L, larva; N, nymph; P, pupa; A, adult.

(d) ECT, ectophagous; END, endophagous.

spp. in their diet. Both of these predictions are borne out by the data (Fig. 1). The proportion of insect pests utilizing the exotic *Sida* spp. may rise as the diversity and intensity of commercial plant cultivation in the Northern Territory increases and as we expand our knowledge of the pest complexes of locally cultivated plants.

At least two species of insect recorded on *S. acuta* and *S. cordifolia* in the Northern Territory have been previously recorded as feeding on *S. acuta* elsewhere in its introduced range. They are *Dysdercus sidae* Montrouzier in Fiji and *C. plebejana* in Vanuatu (Hinckley 1963; Cock 1984 in Waterhouse and Norris 1987). Both species are widespread polyphagous pests of agriculture and their occurrence is not necessarily dependent upon or linked with the presence of *Sida* spp.

Given that one of the aims of conducting a study of this type is to identify vacant niches suitable for exploitation by introduced natural enemies, it is instructive to examine the roles of the insects that have accumulated on to the colonizing *Sida* spp. The distribution of insects among the feeding sites is similar for both *S. acuta* and *S. cordifolia* (Fig. 2), with most species feeding externally on leaves, several on flowers, fruit, seeds and stems, and none on the roots. A closer examination of the plants in the field, however, reveals that this similarity is misleading. Insects frequently reach damaging populations on the flowers fruit, leaves, seeds and stems of *S. cordifolia* but only on the seeds of *S. acuta*.

Virtually all feeding niches on *S. acuta* are underexploited and could be filled by imported natural enemies. Even the seeds are not fully exploited as is demonstrated by the invasive nature of the plant and its persistence from year to year in virtual monocultures. *S. cordifolia* is more fully utilized by phytophagous insects than is *S. acuta* but even it has many underexploited niches. It supports no gall-formers, stem-borers or root-feeders and no insects that are endophagous on the reproductive structures.

The insects that feed upon *S. acuta* in its native range in Mexico (Gillett, Harley and Miranda, unpubl. results) attack all plant parts except the roots (Fig. 2). Many of them are endophagous and hence likely to be relatively host-specific, protected from unspecialized parasites and predators, and structurally damaging the plant. Approximately 10 species were considered to have potential for use as a biological control agent against *S. acuta* in Australia. Unfortunately, due to the uncertainty of the native range of *S. cordifolia*, there have been no studies of phytophagous insects attacking *S. cordifolia* in areas where it might be native, but undoubtedly there exists host-specific, damaging natural enemies capable of exploiting the vacant niches on this plant in Australia.

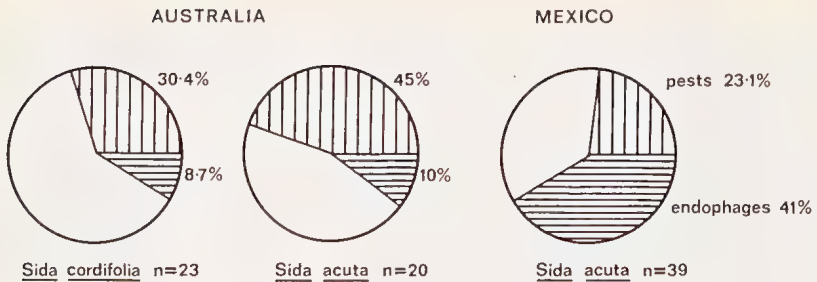


FIG. 1. Comparison of the proportion of endophagous and pest insect fauna of *S. cordifolia* and *S. acuta* in their introduced ranges in the Northern Territory, and *S. acuta* in its native range in Mexico (unpublished data of Gillett, Harley and Miranda).

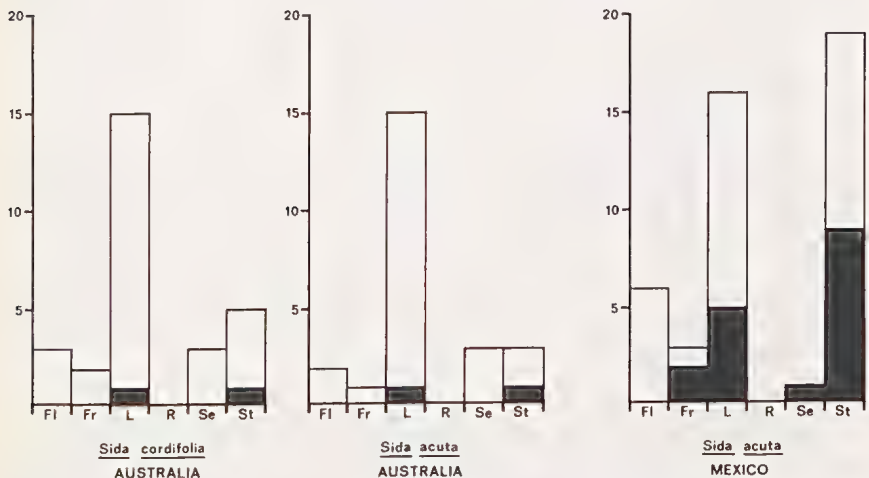


FIG. 2. Comparison of the feeding sites of insects on *S. cordifolia* and *S. acuta* in the Northern Territory, and *S. acuta* in its native range in Mexico (unpublished data of Gillett, Harley and Miranda). Open bars represent ectophagous species and closed bars represent endophagous species. FI, flowers; Fr, fruit; L, leaves; R, roots; Se, seeds; St, stems.



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